

WATER POSSIBILITIES FROM THE
GLACIAL DRIFT OF
BUCHANAN COUNTY

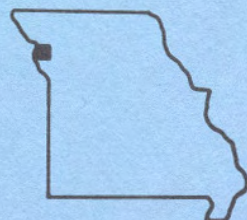
BY

DALE L. FULLER

HARRY PICK

W. B. RUSSELL

JACK S. WELLS



Water Resources Report 14

WATER POSSIBILITIES FROM THE GLACIAL DRIFT
OF BUCHANAN COUNTY

by

Dale L. Fuller, Harry Pick, W. B. Russell,
and Jack S. Wells



1957

STATE OF MISSOURI
Department of Business and Administration
Division of
GEOLOGICAL SURVEY AND WATER RESOURCES
Thomas R. Beveridge, State Geologist
Rolla, Missouri

WATER POSSIBILITIES FROM THE GLACIAL DRIFT OF BUCHANAN COUNTY

A special study of groundwater by the Missouri Geological Survey and Water Resources was made possible at the 1955 session of the Missouri Legislature. With the approval of the Governor, money was appropriated from the Missouri Post War Surplus Reserve Fund.

Since nearly two-thirds of the counties located north of the Missouri River are deficient in water supplies, much of the effort of this special study is being directed toward the problems of this area.

It has been shown that a program of test drilling can locate new reserves of groundwater. Potential areas are being tested so that additional supplies will be available for domestic, irrigation, industrial and municipal needs.

The most favorable areas are in the sand and gravel filled channels and valleys of pre-glacial and inter-glacial streams. Since these buried valleys do not conform to present day drainage patterns, a systematic program of test drilling is a principal means of locating the channels and mapping their extent. Such glacial deposits have proved to be excellent sources of groundwater.

QUALITY OF WATER FROM ROCK WELLS

The water from the consolidated rock formations which underlie Buchanan County is, for the most part, mineralized. The following are analyses from water wells and a test hole.

CONSTITUENTS	IN PARTS PER MILLION		
	A	B	C
Turbidity		Turbid	
Odor		none	
pH			
Alkalinity (CaCO ₃)		288.6	
Phenolphthalein			
Methyl Orange			
Carbonate (CO ₃)	0.0	37.7	0.0
Bicarbonate (HCO ₃)	216.6	313.7	219.6
Silica (SiO ₂)	15.8		24.6
Oxides (Al ₂ O ₃ , Fe ₂ O ₃ , TiO ₂ , etc.)	0.6	8.0*	
Calcium (Ca)	85.4	64.9	170.2
Magnesium (Mg)	36.0	31.3	6.7
Sodium (Na) and Potassium (K) as Na	3206.9	3607.5	3730.0 ¹
Total Manganese (Mn)			
Total Iron (Fe)			
Dissolved Iron			
Precipitated Iron			
Sulfate (SO ₄)	57.2	5.1	0.0
Chloride (Cl)	4910.0	5402.0	6040.0
Nitrate (NO ₃)	0.0		0.0
Fluoride (F)			
Total Suspended Matter			
Total Dissolved Solids	8302.2	9793.0	10292.2
Total Hardness	361.1	289.6	758.4
Carbonate Hardness		288.6	
Non-carbonate Hardness			
Percent of Alkalies	95	96	95

*Al₂O₃, Fe₂O₃
¹Sodium (Na)

A. Owner: Artesian Ice and Cold Storage Co., W 1/2 NW 1/4 SW 1/4 sec. 8, T. 57 N., R. 35 W. Total depth 350 feet bottomed in the Kansas City of the Pennsylvanian System. Flowing well. Analyst: R. P. Rinker.

B. Owner: Bethany Falls Stone Co., NE 1/4 sec. 27, T. 57 N., R. 35 W. Total depth 384 feet. Bethany Falls limestone in first hole at 374 feet. Collected June 6, 1944. Analyst: R. T. Rolufs.

C. Owner: C. T. Ashton, sec. 33, T. 57 N., R. 35 W. Total depth 524 feet. Water horizon from base of Kansas City of the Pennsylvanian System. Analyst: R. P. Rinker.

Referring to Plate 1, it will be noted that a large area of Buchanan County is unfavorably located to obtain water from glacial drift. Wells drilled into the consolidated rock to moderate depths may possibly obtain limited yields of water of marginal quality. The water from "rock" wells in all probabilities will become more mineralized with increased depth of drilling.

QUALITY AND QUANTITY OF WATER FROM STREAMS

The streams of Buchanan County, with the exception of the Missouri River, are intermittent in their flow. Though the quality of water is usually satisfactory, the undependable flow makes all streams other than the Missouri River unsuitable for irrigation or for municipal use.

CONSTITUENTS	IN PARTS PER MILLION	
	I	II
Turbidity	500	40
Odor	none	none
pH	7.9	8.15
Alkalinity (CaCO ₃)	151.5	210.0
Phenolphthalein	0.0	0.0
Methyl Orange	151.5	210.0
Carbonate (CO ₃)	0.0	0.0
Bicarbonate (HCO ₃)	184.8	256.2
Silica (SiO ₂)	8.5	4.4
Oxides (Al ₂ O ₃ , Fe ₂ O ₃ , TiO ₂ , etc.)	0.7	0.8
Calcium (Ca)	58.3	64.5
Magnesium (Mg)	20.0	15.7
Sodium (Na) and Potassium (K) as Na	70.8	15.3
Total Manganese (Mn)	0.00	0.00
Total Iron (Fe)	11.30	0.40
Dissolved Iron	0.12	0.08
Precipitated Iron	11.18	0.32
Sulfate (SO ₄)	176.2	32.0
Chloride (Cl)	15.5	5.8
Nitrate (NO ₃)	0.9	0.0
Fluoride (F)	0.8	0.7
Total Suspended Matter	397.	16.
Total Dissolved Solids	455.	278.
Total Hardness	227.9	225.7
Carbonate Hardness	151.5	210.0
Non-carbonate Hardness	76.4	15.7
Percent of Alkalies	40	13

I. Missouri River at St. Joseph, under Highway 36 bridge. Collected October 21, 1953. Temperature of the water 63° F., of the air 65° F. Analyst: M. E. Phillips.

II. Platte River near Agency. Sec. 28, T. 56 N., R. 34 W. Collected October 25, 1955. Temperature of water 66° F., of the air 73° F. Analyst: M. E. Phillips.

The following are stream flow data from: Bolon, Harry C.,

Surface Waters of Missouri; Missouri Geological Survey and Water Resources,
2d ser., Vol. 34, pp. 201, 274, and 282, 1952.

Missouri River at St. Joseph

Location. - Water-stage recorder, lat. $39^{\circ}45'10''$, long. $94^{\circ}51'28''$,
in sec. 17, T. 57 N., R. 35 W., at St. Joseph & Grand Island Railroad bridge
in St. Joseph. Datum of gage is 788.19 feet above mean sea level, datum of 1929.

Drainage Area. - 424,300 square miles.

Records Available. - August 1928 to September 1949. Gage-height records
collected in vicinity since 1873 are contained in reports of U. S. Weather Bureau.

Average Discharge. - 21 years, 36,120 second-feet.*

Extremes. - 1928-49: Maximum discharge observed, 196,000 second-feet
June 4, 1929; maximum gage height, 21.35 feet Mar. 7, 1949 (ice jam);
minimum discharge, 2,300 second-feet January 9, 1937; minimum gage height,
0.00 foot Dec. 18, 19, 1940.

Maximum stage known, 27.2 feet (present datum) Apr. 29, 1881.

Remarks. - Records good 1940, 41, 49; excellent 1942-48, except those
periods of ice effect, which are generally fair. Drainage basin above station
contains many reservoirs with total usable capacity in excess of 27,174,000
acre-feet.

Cooperation. - Station maintained by U. S. Geological Survey in coopera-
tion with Corps of Engineers. Gage-height during part of period furnished by
U. S. Weather Bureau.

*one second-foot equals 448.83 gallons per minute.

Platte River at Agency

Location. - Chain gage in NE 1/4 sec. 29, T. 56 N., R. 34 W. at
highway bridge in Agency.

Drainage Area. - 1,790 square miles.

Records Available. - May 1924 to August 1930 (discontinued).

Extremes. - 1924-30: Maximum discharge, 22,600 second-feet
Sept. 18, 1926 (gage-height, 26.83 feet); minimum discharge, 24 second-feet
several days during Sept. and Dec. 1927, and Jan. 1928; minimum gage-height,
1.42 feet Jan. 30, 31, 1928.

Maximum stage known, 31.4 feet in July 1915.

Platte River near Agency.

Location. - Wire-weight gage, lat. $39^{\circ}41'20''$, long. $94^{\circ}42'15''$, in
NE 1/4 NW 1/4 sec. 10, T. 56 N., R. 34 W., at bridge on U. S. Highway 169,
1 1/2 miles downstream from Third Fork and 3 1/2 miles northeast of Agency.
Datum of gage is 807.38 feet above mean sea level, datum of 1929.

Drainage Area. - 1,760 square miles.

Records Available. - May 1932 to September 1949. May 1924 to August 1930, at site 4 miles downstream.

Average discharge. - 22 years (1924-29, 1932-49), 795 second-feet.

Extremes. - 1924-30, 1932-49: Maximum discharge, 50,000 second-feet June 23, 1947; maximum gage-height, 30.46 feet June 23, 1947; no flow on several days in July and August 1934.

Remarks. - Records, in general, are fair except those for periods of ice effect, which are poor.

QUALITY OF WATER FROM GLACIAL DRIFT AND ALLUVIUM

In general, the water from the glacial drift is high in total iron, total dissolved solids, and sulfates. Water from the alluvium is generally high in total iron. The iron content in the water may cause staining of plumbing fixtures and laundry; however, relatively inexpensive water treatment for the iron will prevent this staining. For most types of irrigation, total dissolved solids should not exceed 2000 parts per million and total alkalies should not exceed 75 percent. Most people cannot tolerate water for drinking purposes which contains more than 1500 parts per million of chloride, or 2000 parts per million sulfate. Water with 300 parts per million of chloride tastes salty to some people. Sulfates in excess of 500 parts per million may have a laxative effect when first used for drinking.

The following nine analyses are from glacial drift and alluvial wells.

CONSTITUENTS	IN PARTS PER MILLION				
	1	2	3	4	5
Turbidity	Turbid		1-	Turbid	Slight
Odor	Musty		none	none	none
pH			7.35		
Alkalinity (CaCO ₃)	383.9		201.0	213.9	213.9
Phenolphthalein			20.0		
Methyl Orange			181.0		
Carbonate (CO ₃)	0.0	5.4	12.0	0.0	0.0
Bicarbonate (HCO ₃)	468.2	185.5	220.8	260.9	260.9
Silica (SiO ₂)	23.2	7.4	16.0	16.4	16.4
Oxides (Al ₂ O ₃ , Fe ₂ O ₃ , TiO ₂ , etc.)	1.2*		0.8	1.60*	1.20*
Calcium (Ca)	117.6	30.7	73.2	73.2	81.4
Magnesium (Mg)	34.2	28.7	13.8	27.5	23.7
Sodium (Na) and Potassium (K) as Na	96.3	64.1	13.9	56.2	72.4
Total Manganese (Mn)			0.00		
Total Iron (Fe)			0.13		
Dissolved Iron		0.45	0.04		
Precipitated Iron			0.09		
Sulfate (SO ₄)	101.2	156.2	34.3	133.3	152.3
Chloride (Cl)	77.8	15.5	9.3	31.0	66.7
Nitrate (NO ₃)		0.10	6.8		
Fluoride (F)			0.2		
Total Suspended Matter			15.		
Total Dissolved Solids	775.0	480.0	317.	525.0	582.0
Total Hardness	434.2	194.4	239.6	295.8	300.7
Carbonate Hardness	383.9		201.0	213.9	213.9
Non-carbonate Hardness			38.6		
Percent of Alkalies	33	42	11	29	34

*Al₂O₃, Fe₂O₃

1. Owner: Chase Candy Co., 5th & Sylvania, St. Joseph, sec. 8, T. 57 N., R. 35 W. Total depth 72 feet. Collected September 12, 1942. Analyst: R. T. Rolufs.
2. Owner: State Hospital number 2, sec. 10, T. 57 N., R. 35 W. Total depth 95 feet. Glacial drift.
3. Owner: Moffat Nurseries, SW 1/4 SE 1/4 NE 1/4 sec. 6, T. 57 N., R. 34 W. Glacial drift well. Total depth 90 feet. Collected from pressure system June 26, 1957. Analyst: M. E. Phillips.

4. Owner: St. Joseph Ry, Light, Heat & Power Co. well number 2. Total depth 78 feet. Collected June 16, 1942. Analyst: R. T. Rolufs.

5. Owner: Armour & Co., South St. Joseph. Total depth 80 feet in Alluvium. Sampled June 16, 1942. Analyst: R. T. Rolufs.

CONSTITUENTS	IN PARTS PER MILLION			
	6	7	8	9
Turbidity	Turbid	6	150	25
Odor	Musty	none	none	none
pH		7.8	7.4	7.25
Alkalinity (CaCO ₃)	335.0	282.5	563.5	322.5
Phenolphthalein		17.0	0.0	0.0
Methyl Orange		265.5	563.5	322.5
Carbonate (CO ₃)	0.0	10.2	0.0	0.0
Bicarbonate (HCO ₃)	408.5	323.9	687.5	393.5
Silica (SiO ₂)	27.2	13.0	21.5	24.8
Oxides (Al ₂ O ₃ , Fe ₂ O ₃ , TiO ₂ , etc.)	2.00*	0.6	1.8	0.8
Calcium (Ca)	122.4	71.5	149.9	86.4
Magnesium (Mg)	52.3	16.2	45.9	29.0
Sodium (Na) and Potassium (K) as Na	32.1	26.4	19.2	16.7
Total Manganese (Mn)		0.00	1.43	0.98
Total Iron (Fe)		1.06	16.36	5.16
Dissolved Iron		0.04	0.02	0.01
Precipitated Iron		1.02	16.34	5.15
Sulfate (SO ₄)	133.9	5.9	2.2	18.1
Chloride (Cl)	67.6	2.0	7.0	5.8
Nitrate (NO ₃)		0.2	1.2	1.1
Fluoride (F)		0.2	0.2	0.2
Total Suspended Matter		3.	46.	157.
Total Dissolved Solids	753.0	316.	597.	383.
Total Hardness	520.4	245.3	563.2	335.1
Carbonate Hardness	335.0	245.3	563.2	322.5
Non-carbonate Hardness		0.0		12.6
Percent of Alkalies	12	19	7	10

*Al₂O₃, Fe₂O₃

6. Owner: Swift & Co. Alluvial well 80 feet deep. Sampled June 10, 1942. Analyst: R. T. Rolufs.
7. Owner: Hatfield Tire Service, South Highway 71, NE 1/4 NE 1/4 NW 1/4 sec. 26, T. 57 N., R. 35 W. Glacial drift well 207 feet deep. Collected June 12, 1957. Analyst: M. E. Phillips.
8. Owner: Kelsey Nurseries, NW 1/4 NW 1/4 NE 1/4 sec. 1, T. 56 N., R. 36 W. Alluvial well 86 feet deep. 50 gallons per minute. Temperature of water 59° F., of the air 82° F. Sampled June 12, 1957. Analyst: M. E. Phillips.
9. Owner: Kelsey Nurseries, NW 1/4 NW 1/4 SE 1/4 sec. 6, T. 56 N., R. 35 W. Alluvial well 96-100 feet deep. Yield 250 gallons per minute. Temperature of the water 57° F., of the air 82° F. Sampled June 12, 1957. Analyst: M. E. Phillips.

QUANTITY OF WATER FROM GLACIAL DRIFT AND ALLUVIUM





DOMESTIC WELLS - Included in this category are wells developed for household or general farm use. Yields required from domestic wells vary but seldom exceed 15 gallons per minute. In some parts of Buchanan County sands and gravels were not deposited in the glacial drift. There are also areas where the glacial drift cover is relatively thin or lacking. In such areas the possibility of developing wells is limited. Plate 1 shows the area most favorable for the development of domestic wells. Plate 3 is a contour map showing the elevation of bedrock above sea level. To determine probably drilling depths, the elevation of the bedrock should be subtracted from the surface elevation for each specific site. Plate 3 shows the locations of the test holes and the thickness of the glacial drift encountered.

IRRIGATION WELLS - Included in this category are all high yield wells whether used by cities, by industries, or for irrigation. Plate 2 shows the area most favorable for the development of irrigation wells.

MAP OF
BUCHANAN COUNTY
 SHOWING
**AREA MOST FAVORABLE FOR THE DEVELOPMENT
 OF WELLS IN DRIFT AND ALLUVIUM**
 BY
 DALE L. FULLER
 HARRY PICK
 W. B. RUSSELL
 J. S. WELLS
 1937

MISSOURI GEOLOGICAL SURVEY
 AND WATER RESOURCES
 ROLLA, MISSOURI
 THOMAS R. BEVERIDGE
 STATE GEOLOGIST

LEGEND

-  Area most favorable
-  Location of wells in drift and alluvium from which water was analyzed
-  Water sample analyzed from a "rock" well
-  Water sample analyzed from a stream

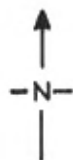
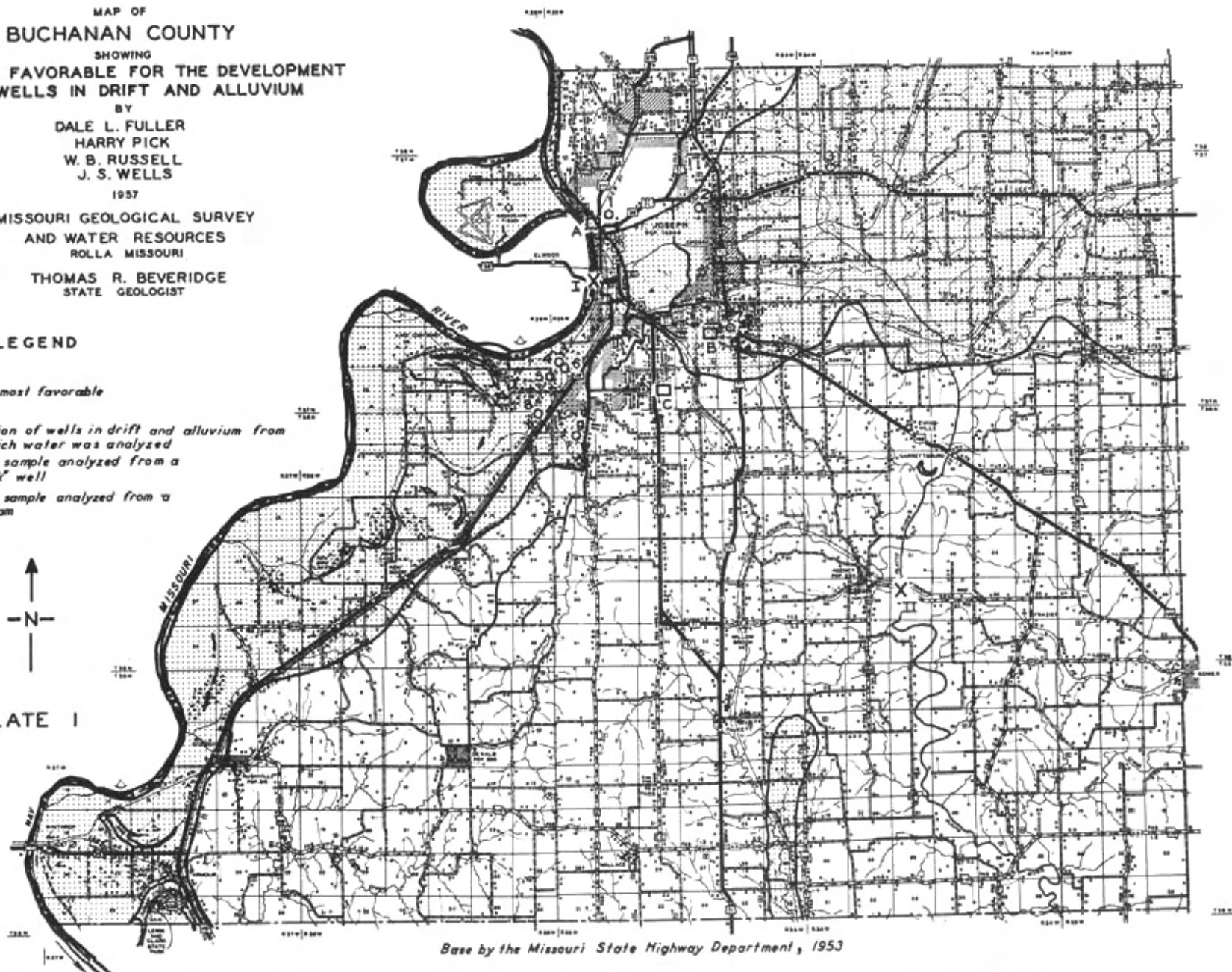


PLATE I



Base by the Missouri State Highway Department, 1953

MAP OF
BUCHANAN COUNTY
SHOWING
ALLUVIAL FILLED VALLEY IN
WHICH IRRIGATION WELLS POSSIBLY
CAN BE DEVELOPED

BY
DALE L. FULLER
HARRY PICK
W. B. RUSSELL
J. S. WELLS
1957

MISSOURI GEOLOGICAL SURVEY
AND WATER RESOURCES
ROLLA, MISSOURI

THOMAS R. BEVERIDGE
STATE GEOLOGIST

LEGEND



Alluvial filled valley



Drift filled valley

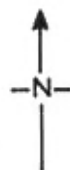
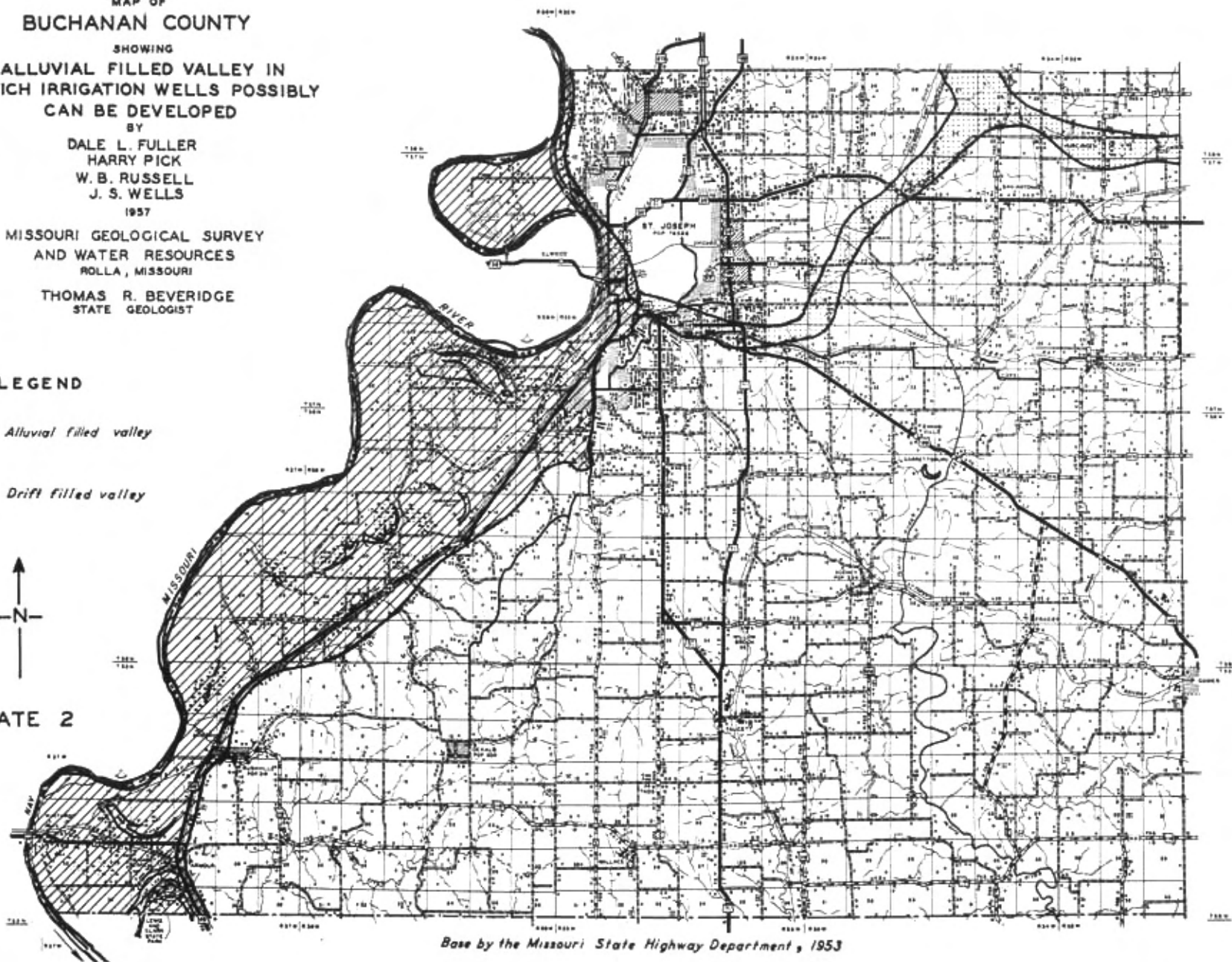


PLATE 2



Base by the Missouri State Highway Department, 1953

MAP OF
BUCHANAN COUNTY
CONTOURED TO SHOW
BEDROCK ELEVATIONS

BY
DALE L. FULLER
HARRY PICK
W. B. RUSSELL
J. S. WELLS
1957

MISSOURI GEOLOGICAL SURVEY
AND WATER RESOURCES
ROLLA, MISSOURI
THOMAS R. BEVERIDGE
STATE GEOLOGIST

LEGEND

- 135
650 Test holes showing thickness in feet
of drift and elevation of bedrock
above sea level
- Water wells
- X Bedrock outcrops
- X Mine or quarry
- 920 Indicates outcrop elevation

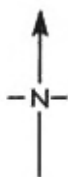
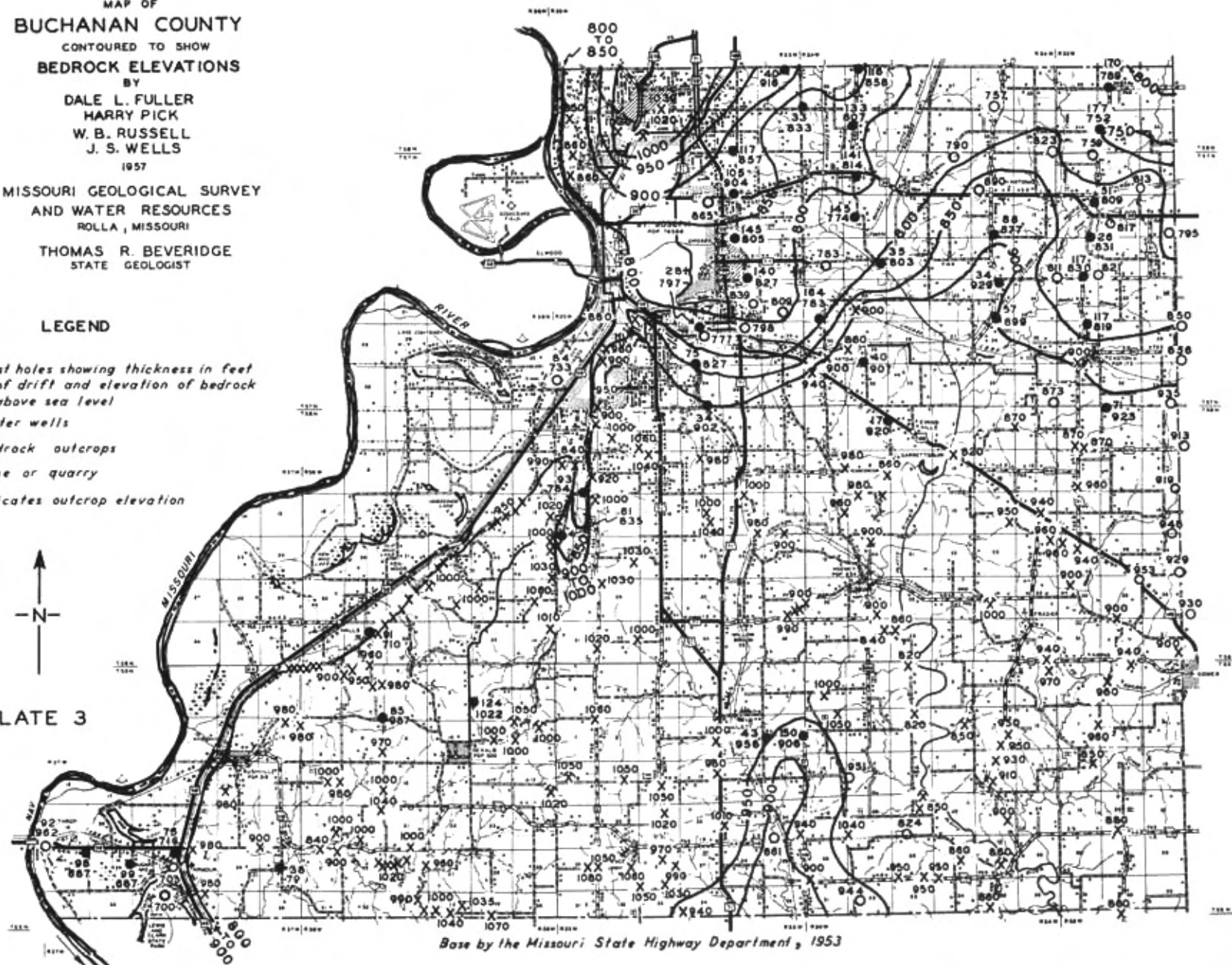


PLATE 3



Base by the Missouri State Highway Department, 1953

With proper development, yields of 200-1000 gallons per minute may be obtained. Yields to be expected are contingent upon several factors:

- (1) The thickness of the sand and gravel beds.
- (2) The size and sorting of the sand and gravel.
- (3) The manner of construction and materials used, such as proper well screen, gravel pack, etc.
- (4) Ability of the well driller to develop the full capacity of the water bearing sands.

Continued successful production is contingent upon:

- (1) Re-charge rate of the water-bearing horizons.
- (2) Quality of the screen and materials used.
- (3) Subsequent well treatment such as acidizing.
- (4) Avoidance of over-pumpage.

S U M M A R Y

Approximately 40,000 acres of Buchanan County are located within the area in which irrigation wells possibly can be developed. Nearly one-third of Buchanan County's area is suitably located for obtaining water sufficient for domestic needs from the glacial drift.

Questions concerning water problems for a specific location should be sent to the Missouri Geological Survey, Rolla, Missouri.